IN THE DRAWINGS:

Please amend Figures 1, 2 and 6 as shown on the attached sheets, including formal replacement sheets and annotated sheets showing the changes made. In Figure 1 several terms are replaced with other terms having similar meaning, but which constitute more idiomatic English. In Figure 2, "near infrared" is replaced with --- NIR ---. In Figure 3 "Secondary-differential" is replaced with --- Second differential --- and --- Value of difference spectrum --- is added as a definition of the values indicated at the right vertical side of the chart.

REMARKS

Upon entry of the present Preliminary Amendment-A the claims in the application remain claims 1-4, of which claim 1 is independent.

Several terms and phrases in the title, specification, claims, drawings and abstract are amended by replacement with alternative terms and phrases having corresponding meaning, but which constitute a more accurate translation of International Application PCT/JP2005/003517 and constitute more idiomatic English. Again, in Figure 1 several terms are replaced with other terms having similar meaning, but which constitute more idiomatic English. In Figure 2, "near infrared" is replaced with --- NIR ---. In Figure 3 "Secondary-differential" is replaced with --- Second differential --- and --- Value of difference spectrum --- is added as a definition of the values indicated at the right vertical side of the chart.

The amendments to the title, specification, and abstract are incorporated in a substitute specification being filed concurrently herewith. Pursuant to 37 CFR 1.125, applicant encloses herewith a clean version of the substitute specification, a marked up copy of the specification showing the changes made thereto, and a verified statement by the undersigned attorney attesting to the fact that no new matter is introduced by the substitute specification.

Applicant respectfully submits that all of the above amendments are fully supported by the original application. Applicant also respectfully submits that the above amendments do not introduce any new matter into the application.

Favorable consideration is respectfully requested.

Respectfully submitted,

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CERTIFICATE OF MAILING

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as First Class Mail in an envelope addressed to Commissioner for Patents, PO Box 1450, Alexandria, VA 22313-1450 on October 18, 2006.

Joseph P. Carrier

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KNJ-235-A

METHOD FOR ~~LEVELING~~STANDARIZING SYSTEM RESPONSE

~~CHARACTERISTICS~~ **OF** ~~SPECTROSCOPE~~**SPECTROPHOTOMETER**

~~DESCRIPTION~~

Cross-reference To Related Applications

[000.1] The present application is the US National Phase of International Application PCT/JP2005/003517, which in turn claims convention priority from Japanese patent application 2004-058443, filed 03 March 2004. The entire disclosures of the referenced International and Japanese priority documents are incorporated herein by reference.

Technical Field

[0001] The present invention relates to a method for ~~leveling a spectroscope~~standardizing system response ~~characteristic for correcting~~ of a spectrophotometer in order to correct the ~~difference between spectroscope response characteristics~~spectrophotometric differences generated due to the difference ~~between~~in response characteristics of a light source, ~~spectrograph~~wavelength selector, and sensor.

Background Art

[0002] To control measurement errors and fluctuations ~~of~~ generated by a plurality of inspection instruments ~~for mass~~in large scale production of products, ~~it~~ the adjustment to fit each instrument is frequently performed ~~to adjust each inspection instrument~~ by using an exclusive ~~jig.~~ tool. However, ~~in the case of calibration of~~when

many check points are present to calibrate the inspection instruments, lots of work times and predetermined man-hours are required ~~when many check points are present~~ and finally, the adjustment cost greatly influences a product price. Therefore, it is preferable to minimize the number of check points ~~requiring adjustment.~~to calibrate the instrument. However, in the case of a product for which accuracy of inspection instrument is requested, artifice is necessary.

[0003] For example, Patent Document 1 describes the following expression as a ~~relative relational expression for showing the correlation~~relationship between the ~~measured value and the~~ true ~~value of a reproduced~~ signal on an optical disk and the measured signal produced by an optical disk inspection instrument in order to reproduce an optical disk ~~to be inspected by an optical disk~~ with similar signal using multi-inspection instruments.

True value Y_i=Gain correction coefficient a_j×measured value X_i+offset correction coefficient b_i (a)

X_i: Measured value of reproduced signal

Y_i: True value of reproduced signal

a_j: Gain correction coefficient for correcting gain for each interval

b_j: Offset correction coefficient for correcting offset for each interval

~~Moreover, the~~The gain correction coefficient a_j and the offset coefficient b_j are obtained for each interval. ~~Furthermore,~~ Patent Document 1 describes a method for calibrating ~~measurement means~~each optical disk inspection instrument in accordance with [[a-]] the calibrated ~~value~~values obtained by using ~~the computing means and~~expression (a). Furthermore, Patent Document 1describes a method for inspecting an optical disk to be inspected ~~is described in Patent Document 1.~~using calibrated inspection instruments

Patent Document 1: Japanese Patent Application Publication No. 2003-1897440

~~Disclosure~~Summary of the Invention

[0004] However, when an object to be inspected has a frequency (wavelength) ~~characteristic~~response more complex than that of an optical disk~~ and the reflection~~, for example, spectrum of an apple ~~is~~ measured in a wavelength range of 700 to 1,100 nm by using~~, for example,~~ a ~~discrete~~dispersive-type near infrared ~~apparatus~~instrument, there is a problem that individual difference between objects to be measured is large~~, which is not present~~r than that presented in an optical disk.

Though the approximate expression (a) shown in Patent Document 1 is used, it is impossible to find a proper linear correction parameter as shown by linear correction data in Table 1.

Also when using the following approximate expression (b) using a more-complex polynomial,

$$y = k_0 + k_1 s + k_2 x^2 \qquad \text{(b)}$$

it is impossible to find a proper polynomial parameter as shown by the polynomial correction data in Table 1.

[0005]—

[Table 1]

Adjustment ~~line~~ condition	Calibration method	
	MLR	PLS

	SEP	Bias	SEP	Bias
No adjustment	0.34	-0.42	0.35	-0.53
700-1,100 nm linear correction	0.34	-1.07	0.32	-1.31
700-1,100 nm polynomial correction	0.34	-0.48	0.31	-1.14
850-1,050 nm linear correction	0.34	-0.46	0.32	-1.24
850-1,050 nm polynomial correction	0.34	0.25	0.31	-1.06

(Note 1) Analysis algorithm

MLR (Multiple Linear Regression)

PLS (Partial Least Squares)

(Note 2)

SEP: Residual-error standard error (~~Standard error of bias~~Bias-corrected ~~expected value)~~standard error of prediction)

Bias: Average of differences between ~~estimated values and chemical analysis~~ actual values according to chemical analysis and estimated values according to near infrared spectroscopy

[0006] Moreover, when moving a calibration model (hereafter referred to as model) for performing quantitative analysis and qualitative analysis by using the near infrared spectroscopy from a unit developing the model to another similar unit, an error occurs due to the difference between ~~spectral apparatus response characteristics.~~spectrophotometric system responses. In the case of the quantitative analysis, there is a method referred to as bias correction method of the model as a correction method. However, this method is ~~correction of~~ to correct an estimated result~~,~~ which requires correction for each model and labor and whose operation is complicated.

However, the correction method for qualitative analysis is not developed yet.

[0007] It is an object of the present invention to provide a method for ~~leveling response characteristics~~ standardizing system response of a ~~spectroscope~~spectrophotometer for correcting the distortion of a spectrum generated due to the difference between ~~spectroscope response characteristics~~ system responses of spectrophotometers so that a model developed by a ~~parent~~master unit can be used by a ~~child~~slave unit.

To achieve the above object, a method of the present invention for ~~leveling~~standardizing the system response ~~characteristic~~ of a ~~spectroscope provides a method for~~spectrophotometer involves adjusting the system response ~~characteristic~~ of a ~~child~~slave unit to the system response ~~characteristic~~ of a ~~parent~~master unit by ~~subtracting the spectrum of a standard substance measured by the parent unit, for example, secondary-differential spectrum from the spectrum of the standard substance measured by the child unit, for example, secondary-differential spectrum thereby obtaining the difference spectrum between the child unit and the parent unit, and thereby subtracting the difference spectrum from the secondary-differential spectrum of each sample to be measured by the child unit.~~calculating the difference spectrum between the slave unit and the master unit. For example, the difference spectrum may be calculated by subtracting a spectrum of a standard material, for example, a second derivative spectrum, measured by the slave unit~~, for~~ from a second derivative spectrum of a standard material measured by the master unit. Then the spectrum of each object measured by the slave unit is standardized by subtracting with the calculated difference spectrum. By using the ~~secondary-differential~~second derivative spectrum for calculating the difference spectrum, there is an advantage that ~~the~~baseline shift ~~of the base line~~ is eliminated.

[0008] As the spectrum of the standard ~~substance~~material, the spectrum of a sample to be measured, ~~secondary-differential~~second derivative spectrum, or average spectrum of ~~the spectrum of the sample and the secondary-differential spectrum~~those spectra mentioned before is considered. In the case of the average spectrum, the following two cases are assumed: a case of measuring a plurality of ~~spectrums~~spectra by one sample to be measured and obtaining the average spectrum and a case of measuring a plurality of ~~spectrums~~spectra by a plurality of samples and obtaining the average spectrum.

[0009] An ~~apparatusapparatus~~instruments to which near infrared spectroscopy is applied is constituted of a ~~beam of light, spectrograph,~~ light source, ~~spectrograph~~wavelength selector, and sensor. Wavelength characteristics, ~~luminances~~light intensity, and sensor sensitivities of ~~themthem~~spectrophotometer are delicately different for each individual ~~piecepiece~~instrument and the combination of ~~spectroscope response characteristic which isis~~these responses gives the overall characteristic of the instrument which is ~~apparatus is delicately different for each apparatus. Moreover~~delicately different for each instruments. ~~Moreover~~In addition, a shift of the wavelength ~~of a spectroscopespectroscope~~between each spectrophotometer occurs. However, the ~~spectroscope response characteristic is peculiar to each apparatuscharacteristic~~spectrophotometric system response is ~~peculiar~~specific to each ~~apparatus~~instrument when a light source, ~~spectrograph~~wavelength selector, and sensor are decided.

[0010] Therefore, because a shift of absorbance value of a ~~childchild~~slave unit in each wavelength from a ~~parentparent~~master unit similarly occurs in each sample to be measured, it is possible to correct a spectrum distortion generated due to the difference between ~~spectroscope response characteristicscharacteristics~~spectrophotometric system responses by subtracting the shift of the absorbance value in each wavelength

from the spectrum of each sample, for example, second~~ary differential~~ derivative spectrum.

[0011] ~~According toto~~By using the present invention, in the case of a fruit ~~sugar content selector~~sweetness sorting machine, it is easy to ~~move a sugar-content analytical distillation developed by a reference selection line (parent unit)~~transfer a mathematical model to predict sweetness developed from spectra of a master unit to a plurality of other ~~selection lines (child unit),~~sweetness sorting units (slave units). By this invention, the difference between lines is eliminated, and the reliability of the ~~selectorselector~~sweetness sorting machine is improved. Moreover, there are advantages that the ~~selectorselector~~sweetness sorting machine is easily maintained and persons are released from the hard work at the job site for correcting the difference between lines~~.~~ by the conventional bias-correction technique.

Brief Description of the Drawings

[0012] Figure 1 is an illustration showing an example of an apple ~~sugar content selector;~~sweetness sorting machine;

Figures 2(a) and 2(b) are illustrations showing second~~ary differential spectrums~~ derivative spectra measured by near infrared ~~apparatuses(near infrared apparatuses~~NIR) instruments A and B;

Figure 3 is an illustration showing an example of applying a model developed by the ~~near infrared apparatusapparatus~~NIR instrument A to the spectrum of the ~~near infrared apparatusapparatus~~NIR instrument B;

Figure 4 is an illustration showing a difference spectrum obtained by subtracting the ~~secondary~~second~~dary differential~~ derivative spectrum of an apple

measured by the ~~near infrared apparatusapparatus~~NIR instrument A from that of an apple measured by the ~~near infrared apparatusapparatus~~NIR instrument B;

Figure 5 is an illustration showing an example of applying a model developed by the ~~near infrared apparatusapparatus~~NIR instrument A to the ~~leveling spectrumspectrum~~standardized spectra of the ~~near infrared apparatusapparatus~~NIR instrument B; and

Figure 6 is an illustration showing a difference spectrum obtained by subtracting the average spectrum of second~~ary differential spectrums~~ derivative spectra measured by a ~~parentparent~~master unit from the average spectrum of second~~ary differential spectrums~~ derivative spectra measured by a ~~childchild~~slave unit and the average spectrum of the ~~parentparent~~master unit.

~~**Best Mode for Carrying Out**~~Detailed Description of the Invention

[0013] ~~Best~~A best mode for carrying out the invention is described below. Figure 1 is one of the embodiments of the present invention, which shows an example of an apple ~~sugar-content selector.~~sweetness sorting machine. In the case of the ~~selector~~sweetness sorting machine, a tungsten lamp is used for the light source, a ~~diffraction~~ grating is used for the ~~spectrograph~~wavelength selector, and a diode array detector is used for the sensor.

[0014] At the stage for preparing a model by the ~~parentparent~~master unit in Figure 1(1), a plurality of samples (apples) 1 to be measured are measured by the sensor 2 of the ~~parentparent~~master unit to obtain the second~~ary differential spectrum~~ derivative spectrum 3 of the ~~parentparent~~master unit. Then, chemical ~~analysisanalysis~~component values 4 of the samples (apples) 1 are obtained. A model 5 is obtained by the chemometrics method such as the multiple regression ~~analysis in~~

~~accordance withwith~~based on the data for the above second~~ary differential~~ derivative spectrum 3 and the above chemical component values 4.

[0015] At the stage for obtaining the difference between spectral characteristics of the ~~parentparent~~master unit and ~~childchild~~slave unit in Figure 1(2), a plurality of samples (apples) 6 to be measured are measured by the sensor 2 of the ~~parentparent~~master unit to obtain the average spectrum of the second~~ary differential spectrums~~ derivative spectra of the ~~parentparent~~master unit. Then, the same samples (apples) 6 to be measured are measured by the sensor 8 of the ~~childchild~~slave unit to obtain the average spectrum 9 of the second~~ary differential spectrums~~ derivative spectra of the ~~childchild~~slave unit. Moreover, the difference spectrum 10 ~~between secondary differential values~~of second derivative values is obtained by subtracting the average spectrum 7 of the ~~parentparent~~master unit from the average spectrum 9 of the ~~childchild~~slave unit.

At the stage for ~~levelingleveling~~standardizing the spectral characteristics of the ~~childchild~~slave unit in Figure 1(3), each sample (apple) 11 to be measured is measured by the sensor 8 of the ~~childchild~~slave unit and the second~~ary differential~~ derivative spectrum 12 of the ~~childchild~~slave unit is measured to obtain a ~~leveledleveled~~standardized second~~ary differential~~ derivative spectrum 13 obtained by subtracting the difference spectrum 10 from the second~~ary differential~~ derivative spectrum 12. By applying the model 5 to the ~~leveledleveled~~standardized second~~ary differential~~ derivative spectrum 13, a purposed chemical component value 14 is obtained.

[0016] Figure 2 ~~isis~~shows near infrared second~~ary differential spectrums~~ derivative spectra of apples (~~product class~~variety: Fuji) measured by two ~~discreted~~dispersive-type near infrared ~~apparatusesapparatuses~~instruments (~~NIRS6500 made by NIR Systems~~NIR~~,~~ Systems, NIRS6500) (referred to as ~~near infrared~~

~~apparatusesapparatuses~~NIR instruments A and B). The near infrared ~~apparatusapparatus~~instrument uses a tungsten lamp as a light source, a ~~diffraction~~ grating as a ~~spectrograph~~wavelength selector, and a silicon detector as a sensor.

[0017] The following model ~~of the following expression~~ is developed ~~throughthrough~~by multiple regression ~~in accordance withwith~~based on the second~~ary differential~~ derivative values measured by the NIR instrument A and sugar contents (Brix values) of ~~spectrums of~~ 100 apples. ~~measured by the near infrared apparatus A.~~

$$C = 16.035 - 266.386D2A(906) + 1351.578D2A(870) \quad \ldots (1)$$

~~In this case~~Where, C ~~denotes~~ is a Brix value, and D2A(906) and D2A(870) are second~~ary differential~~ derivative values of ~~spectrumsspectrums~~spectra at 906 nm and 870 nm, respectively.

[0018] Figure 3 shows results of applying the model of the above expression (1) to a spectrum measured by the ~~near infrared apparatusapparatus~~NIR instrument B. In this case, it is found that a negative bias of -0.42° Brix is generated.

[0019] Figure 4 is a difference spectrum obtained by subtracting the average spectrum of ~~the near infrared apparatus A from the average spectrum of secondary differential spectrums~~ second derivative spectra of the above 100 apples measured by the ~~near infrared apparatusapparatus~~NIR instrument A from the average spectrum of second~~ary differential spectrums~~ derivative spectra of the ~~above 100 apples~~same samples measured by the ~~near infrared apparatus~~NIR instrument B. Figure 4 shows the wavelength range of 860 to 910 nm to be used for the model. It is found that the second~~ary differential~~ derivative value of the ~~near infrared~~

~~apparatusapparatus~~NIR instrument B is slightly larger than that of the ~~near infrared apparatusapparatus~~NIR instrument A in the wavelength region. At 906 nm, the second~~ary differential~~ derivative value is ~~large~~larger by 0.0021515 and at 870 nm, the value is large by 0.0008103. Therefore, when assuming that the second~~ary differential~~ derivative values at 906 nm and 870 nm of the ~~near infrared apparatusapparatus~~NIR instrument B are $D2A(906)_B$, and $D2A(870)_B$, respectively, a corrected value is obtained from the following expression.

$$D2A(906) = D2A(906)_B - 0.0021515$$

$$D2A(870) = D2A(870)_B - 0.0008103 \quad \ldots (2)$$

By substituting the value of expression (2) for the model of expression (1), it is possible to apply the model developed by the ~~near infrared apparatusapparatus~~NIR instrument A to the spectrum measured by the ~~near infrared apparatusapparatus~~NIR instrument B.

[0020] Figure 5 shows results of correcting and recalculating the data shown in Figure 3 by the above described method. A bias becomes 0.05° Brix and occurrence of errors produced due to the difference between ~~spectroscope response characteristicscharacteristics~~system responses of spectrophotometers is almost cancelled. This improvement degree is clear as a result of comparing with calibration result data of linear correction and polynomial ~~expression~~ correction in Table 1.

[0021] Figure 6 shows a difference spectrum obtained by subtracting the average spectrum of second~~ary differential spectrums~~ derivative spectra measured by the ~~parentparent~~master unit from the average spectrum of second~~ary differential spectrum~~ derivative spectra measured by the ~~childchild~~slave unit and the average spectrum of the ~~parentparent~~master unit in a wavelength region of 850 to 1,050 nm together. When assuming a difference spectrum as $\Delta A(\lambda)$ and a second~~ary differential~~ derivative

spectrum of each ~~a~~ sample measured by the ~~childchild~~slave unit as $S_B(\lambda)$, a ~~leveledleveled~~standardized second~~ary differential~~ derivative spectrum $S_C(\lambda)$ is shown by the following expression.

$$S_C(\lambda) = S_B(\lambda) - \Delta A(\lambda) \quad \text{... (3)}$$

~~In this case, λ denotes~~Where, λ ~~denotes~~is a wavelength (nm).

Industrial Applicability

[0022] It is possible to apply ~~leveling of the spectroscope response characteristiccharacteristic~~the ~~standardization~~ method for standardizing~~of~~ system response of spectrophotometer by the present invention to ~~a line for measuring~~, for example, a sweetness sorting machine which measures the spectrum of fruit moved by~~, for example,~~ a belt conveyer and ~~selecting~~selects~~ing~~ the fruit in accordance with ~~a chemical component value such as~~ an obtained sugar content.

[0023] Although there have been described what are the present exemplary embodiments of the invention, it will be understood that variations and modifications may be made thereto within the spirit and scope of the appended claims.

ABSTRACT

A method for ~~leveling spectroscope response characteristics~~standardizing system response of spectrophotometer which corrects the difference between ~~spectroscope response characteristics~~spectrophotometric system responses generated due to the difference ~~between~~in response characteristics of a light source, ~~spectrometer~~wavelength selector, and sensor, and involves obtaining the difference spectrum between a ~~parent~~master unit and a ~~child~~slave unit relative to a standard ~~substance~~material and ~~adjusting~~standardizing the response characteristic of the ~~child~~slave unit to the response characteristic of the ~~parent~~master unit by subtracting the difference spectrum from the spectrum of each sample to be measured by the ~~child~~slave unit. With an ~~apparatusapparatus~~instrument which is constituted of a light source, ~~spectroscope~~wavelength selector, and sensor and to which a ~~near-infrared~~NIR spectroscopy is applied, a shift of an absorbance value ~~inin~~at each wavelength of the ~~childchild~~slave unit from the absorbance value of the ~~parentparent~~master unit is similarly generated in each sample to be measured. ~~Therefore, by~~By subtracting the shift of the absorbance value at each wavelength from the spectrum of each sample, it is possible to correct the spectrum distortion generated due to the difference between system response ~~characteristics of spectroscopes~~of spectrophotometer.

FIG. 1

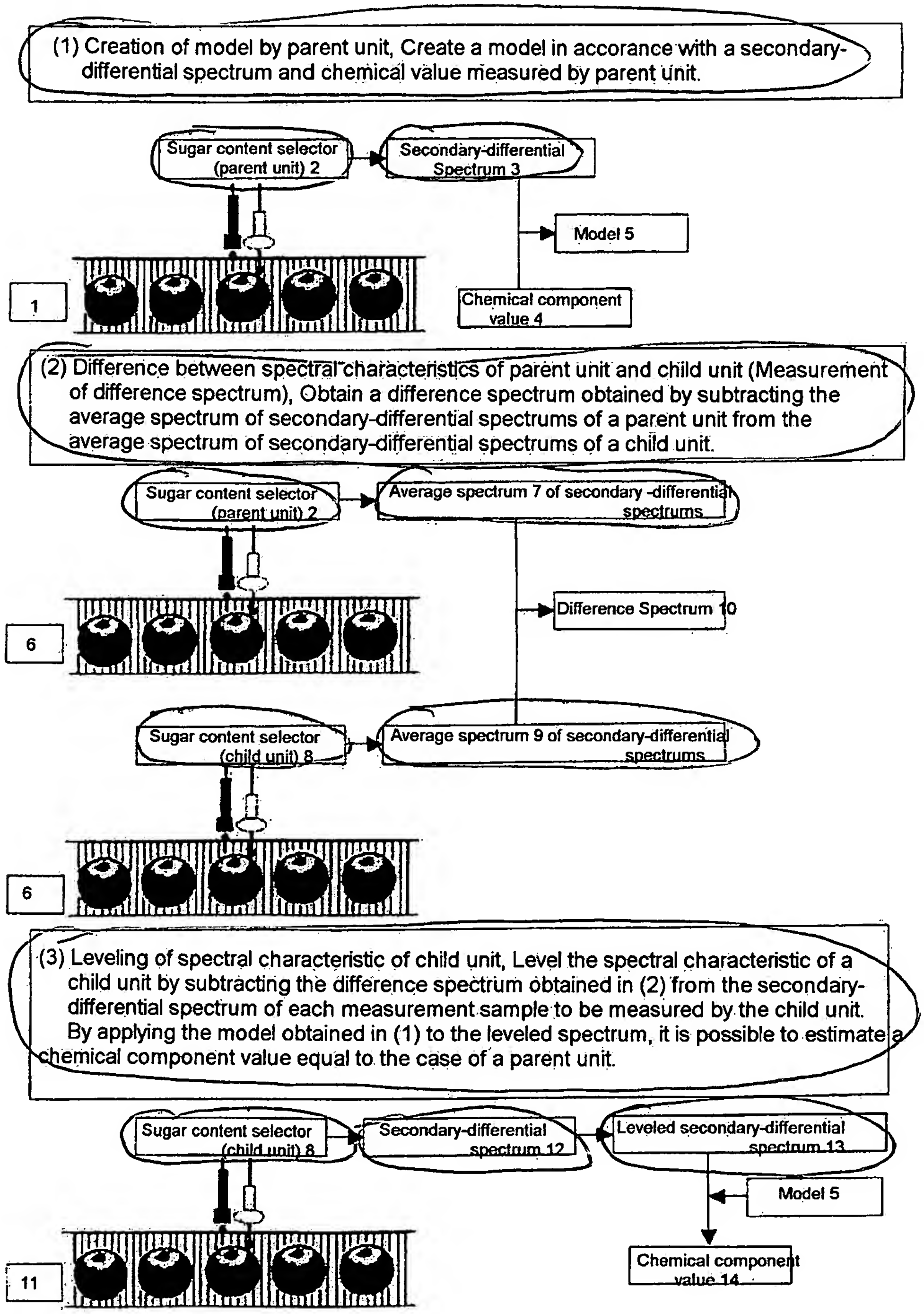
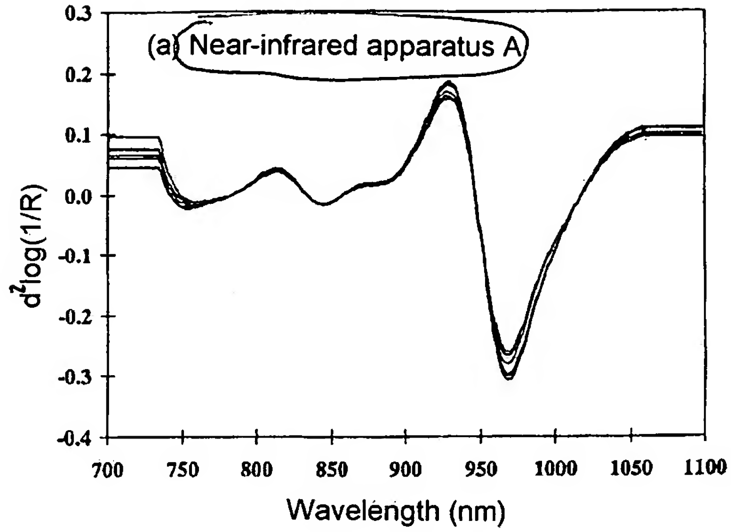

(1) Creation of model by parent unit, Create a model in accorance with a secondary-differential spectrum and chemical value measured by parent unit.
Sugar content selector (parent unit) 2
Secondary-differential Spectrum 3
Model 5
1
Chemical component value 4
(2) Difference between spectral characteristics of parent unit and child unit (Measurement of difference spectrum), Obtain a difference spectrum obtained by subtracting the average spectrum of secondary-differential spectrums of a parent unit from the average spectrum of secondary-differential spectrums of a child unit.
Sugar content selector (parent unit) 2
Average spectrum 7 of secondary -differential spectrums
Difference Spectrum 10
6
Sugar content selector (child unit) 8
Average spectrum 9 of secondary-differential spectrums
6
(3) Leveling of spectral characteristic of child unit, Level the spectral characteristic of a child unit by subtracting the difference spectrum obtained in (2) from the secondary-differential spectrum of each measurement sample to be measured by the child unit. By applying the model obtained in (1) to the leveled spectrum, it is possible to estimate a chemical component value equal to the case of a parent unit.
Sugar content selector (child unit) 8
Secondary-differential spectrum 12
Leveled secondary-differential spectrum 13
Model 5
11
Chemical component value 14

FIG. 2


(a) Near-infrared apparatus A
$d^2log(1/R)$
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
700
750
800
850
900
950
1000
1050
1100
Wavelength (nm)

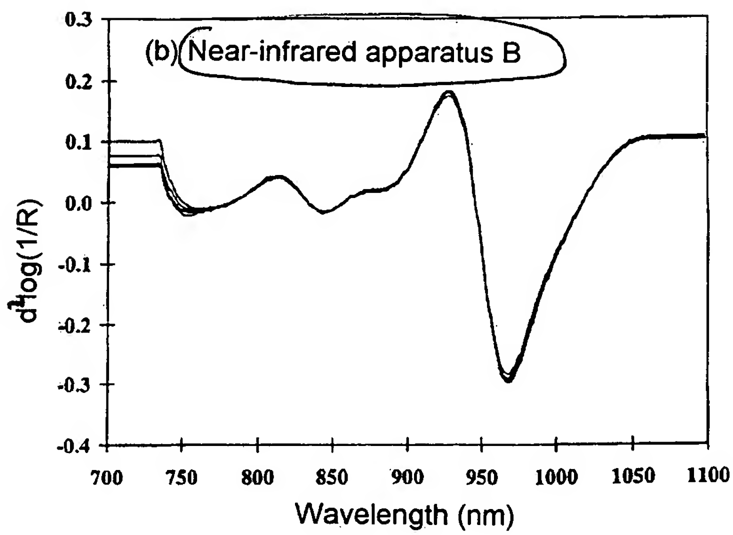
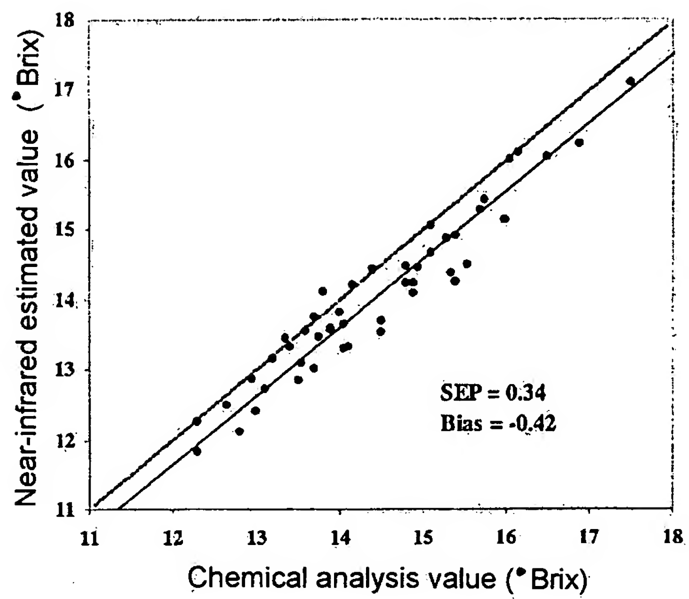
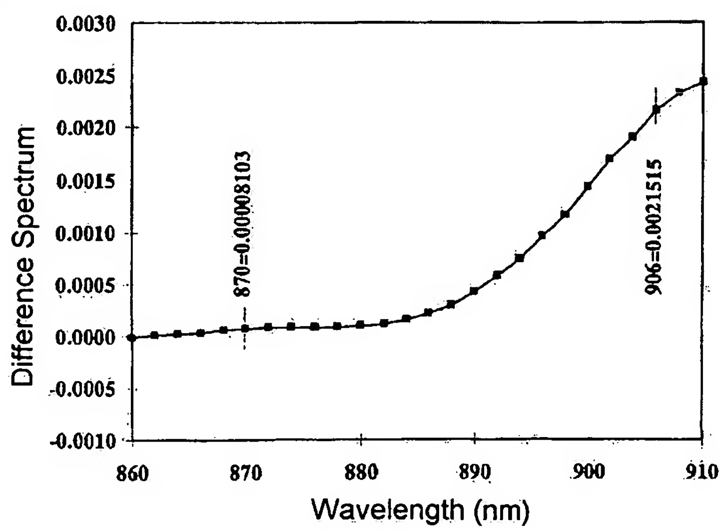

(b) Near-infrared apparatus B
$d^2log(1/R)$
0.3
0.2
0.1
0.0
-0.1
-0.2
-0.3
-0.4
700
750
800
850
900
950
1000
1050
1100
Wavelength (nm)

FIG. 3



Near-infrared estimated value (°Brix)
18
17
16
15
14
13
12
11
11
12
13
14
15
16
17
18
SEP = 0.34
Bias = -0.42
Chemical analysis value (°Brix)

FIG. 4



Difference Spectrum
0.0030
0.0025
0.0020
0.0015
0.0010
0.0005
0.0000
-0.0005
-0.0010
870=0.00008103
906=0.0021515
860
870
880
890
900
910
Wavelength (nm)

FIG. 5

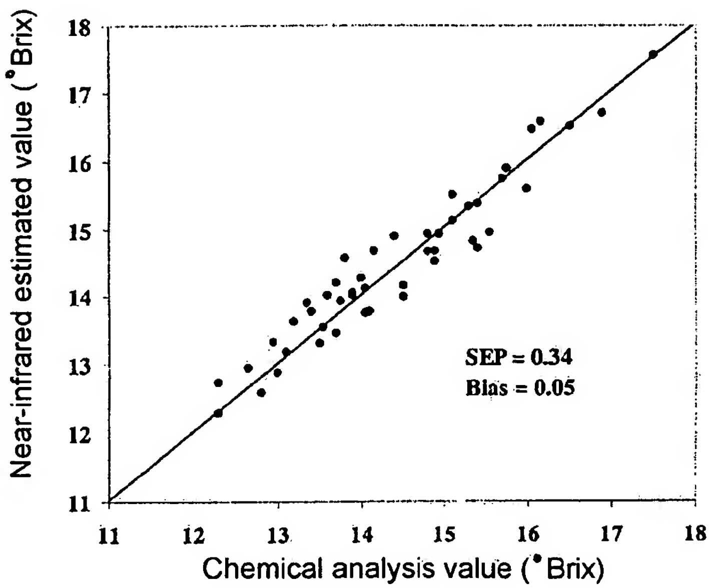
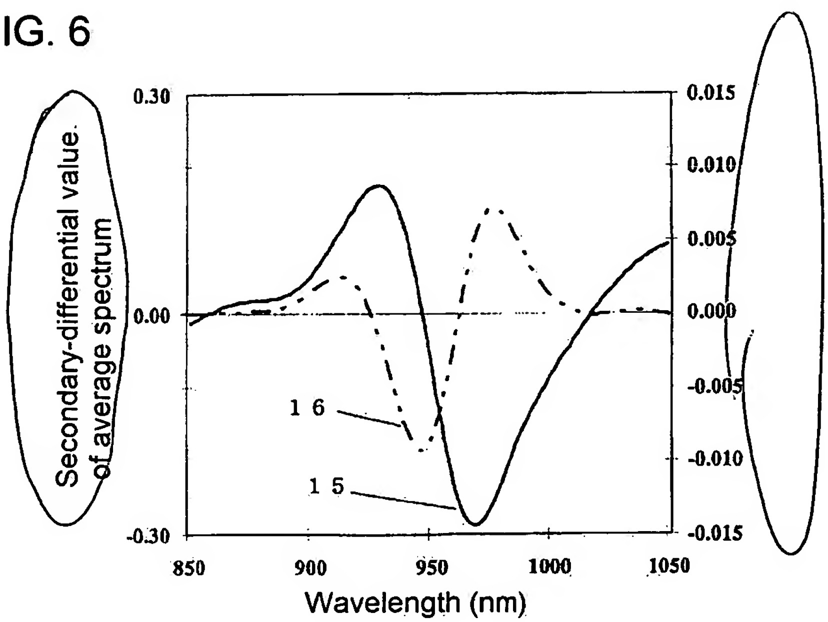

Near-infrared estimated value (°Brix)
18
17
16
15
14
13
12
11
SEP = 0.34
Bias = 0.05
11 12 13 14 15 16 17 18
Chemical analysis value (°Brix)

FIG. 6


Secondary-differential value of average spectrum
0.30
0.00
-0.30
0.015
0.010
0.005
0.000
-0.005
-0.010
-0.015
16
15
850 900 950 1000 1050
Wavelength (nm)